TeV Energy Superconducting Linear Accelerator

The TESLA Cryo-Plants

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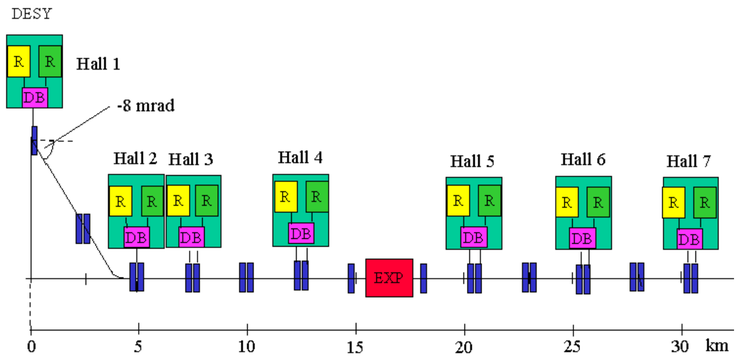
Comparison of TESLA 500 and CERN-LHC Helium Refrigerators

Similarities	
Number of refrigeration stations	8 at LHC 7 at TESLA
Distance between refrigerator stations	About 5 km
Nominal rate of refrigeration per refrigerator	18 kW at LHC 24 kW at TESLA
Superfluid helium cooling	1,7 K at LHC 1,9 K at TESLA
Same helium inventory	About 100 t

Advantages of TESLA	
Comes later	Can learn from LHC
TESLA starts on the green meadow	LHC is modified LEP system
Lower depth below ground	All refrigerator equipment can be installed above ground
Mostly horizontal	Easier helium level control
8 times smaller cold mass	Easier cool-down and warm-up
Transfer lines inside cryostat	Easier to distribute cooling

Disadvantages of TESLA	
Low design pressure of cryostats	Emergency power is needed to handle helium on power outage
Larger difference between static and dynamic load	Transients have to be investigated more carefully
Later upgrade to TESLA 800	Some early investment is necessary



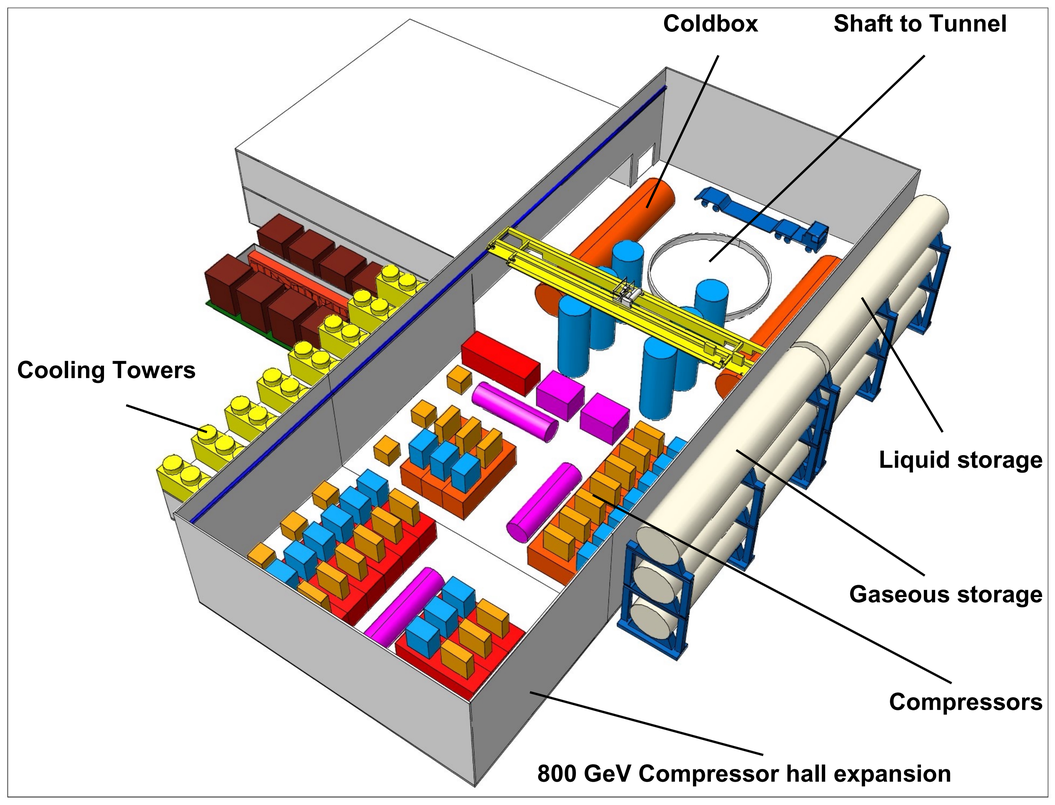
Main Sources of Unavailability in Existing Refrigerators

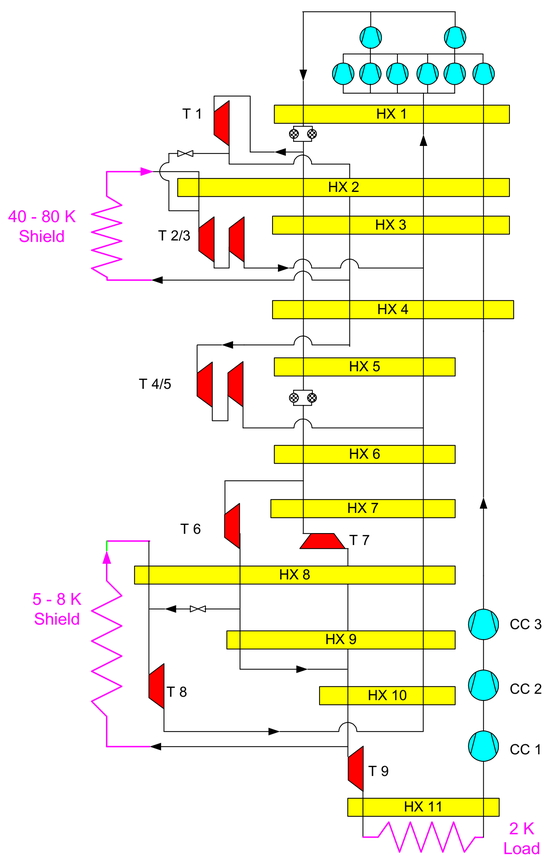
Rating	Source of unavailability	Example	Multiple refrigerators ...
1	External utility failures	Electrical power, cooling water, instrument air failure	would bring no advantage
2	Blockage by frozen out gaseous impurities	Air and/or water vapor	provide somewhat larger tolerance
3	Operational problems	Controls, instrumentation, operators	would be detrimental, because of higher complexity of the system
4	Single component failure not leading to total plant shutdown	Electrical motor burnout, compressor bearings, leaking oil pump seal, turbine bearing trouble	would bring no advantage over component redundancy within a single refrigerator
5	Catastrophic component failure leading to plant shutdown	Loss of insulation vacuum, rupture of heat exchanger, oil spill into cold process piping	would have a positive effect

Based on this investigation it was decided, to use only one large refrigerator in each hall for the 500 GeV system. For the 800 GeV system a second refrigerator would be added.

Equipment List

	Hall 1	Hall 2	Hall 3	Hall 4	Hall 5	Hall 6	Hall 7	**Total**
Compressors								
LP stage	6	5	7	7	7	8	7	
HP stage	3	3	3	3	3	3	3	
Total	9	8	10	10	10	11	10	**68**
Coldbox	1	1	1	1	1	1	1	**7**
Distribution Box	1	1	1	1	1	1	1	**7**
Users	2	1	2	2	2	3	2	**14**
Cold Compressors	8	8	8	8	8	8	8	**56**
Liquid Storage	1	1	1	1	1	1	1	**7**
Warm Gas Storage	3	3	5	5	5	5	5	**31**





Process Parameters of the Model Refrigerator

		Mass flow	Outlet	Return
2 K Load	4253 W	199.4 g/s	1.1 bar 2.2 K	0.0275 bar 2.0 K
5 – 8 K Shield	7465 W	249.8 g/s	5.5 bar 5.16 K	5.0 bar 8.2 K
40 – 80 K Shield	80788 W	383.3 g/s	16.0 bar 40 K	14.0 bar 80 K
Compressors				
LP I		199.4 g/s		0.92 bar 295 K
LP II		1369 g/s		1.4 bar 295 K
HP		1568.4 g/s	24.0 bar 300 K	

Power Consumption	Refrigeration	COP	Specific Load	% of Power
2 K	4.253 kW	588 W/W	2500 kW	49 %
5 – 8 K	7.465 kW	168 W/W	1254 kW	24 %
40 – 80 K	80.788 kW	17 W/W	1373 kW	27 %
Total			5147 kW	100 %